Shearing and Compression of Aggregated Slurries (Invited)

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When compacted in a pressure filter slurries come to rest at a volume fraction that depends on the strength of the interparticle forces. Compacted beds of aggregated particles can then support loads up to that used to build them by elastic deformation If larger pressures are applied, the beds compact to a higher volume fraction. One approach to understand how the bed's compressive strength develops would be to draw an analogy between aggregated suspensions and granular materials. Noncohesive granular materials support loads by being jammed with the stress being supported solely by compressive interparticle contacts that form a force net in the suspension. In this scenario a few particles feel a compressive force much larger than the average and are surrounded by spectator particles that feel a force much smaller than the average. Non-cohesive granular materials are said to be fragile in that the force network supporting shear or compressive loads is built in response to that applied load. Shifts in the direction in which the load is applied results in substantial rearrangement of the force net and sometimes catastrophic failure. In this talk we discuss the load carrying capacity of suspensions of attractive particles for which interparticle contacts support compressive as well as tensile load and compare and contrast the observed behavior with that seen in granular materials. We work with particles experiencing attractive forces of sufficient strength that the suspensions gel or display a yield stress at volume fractions substantially less than close packing. We observe volume fraction changes when the suspensions are subjected to both oscillatory and continuous shear while experiencing a compressive load. Small oscillatory strains result in catastrophic failure with the beds compacting to close packing. This result provides strong evidence for fragility. On the other hand, under the same compressive loads, these suspensions can sustain continuous shear with no changes in volume fractions up to a critical shear rate after which, at fixed volume fraction, the bed strength decays as $(1 - (\gamma/\gamma^*)^{1/2}$. Here γ is the shear rate. The critical shear rate, γ^*, is independent of volume fraction, but dependent on the strength of interparticle forces. The ability of the beds to sustain continuous shear without collapsing, but to collapse under small oscillatory strains is discussed.